Attorney Docket: 200209576-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: Mei

Serial No.: 10/769,127 Group Art Unit: 2822

Filed: Jan 30, 2004 Examiner: Tran, Thanh

For: Forming a Semiconductor Device

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

DECLARATION UNDER 37 C.F.R. 1.131

I Ping Mei, hereby declare that:

1. I am the inventor of the subject matter recited in the claims of the above-identified application.

2. Prior to July 29, 2003, I conceived of the idea of forming a semiconductor device by forming a 3-D pattern in a substrate and depositing at least one material over the substrate with desired characteristics of the semiconductor device.

3. I conceived of this idea while working for the Hewlett-Packard Corporation in Palo Alto, CA.

4. Attached Exhibit A is a document that I prepared summarizing the invention conceived for the Hewlett-Packard Corporation. Page 3 includes a section labeled "Description of the construction and operation of the invention" setting forth a description of my invention, as described and claimed in my application.

5. Attached Exhibit B is letter dated April 9, 2003 retaining Wendell J. Jones as patent counsel to prepare a patent application for the described invention.

6. Attached Exhibit C is an email that was sent on November 6, 2003 including a first draft of a set of claims.

7. Attached Exhibit D is an email that was sent on December 19, 2003 including a first draft of the patent application.

8. On January 30, 2004, the present patent application describing and claiming my invention was filed.

I hereby declare that all statements made in this declaration of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Ping Mei

April 26, 2006

Ping Mei Date

HPL INVENTION DISCLOSURE

IAL PAGE 1 OF 1

invent

PDNO: 20020957-0 DATE RCVD: 10/16/02 ATTORNEY: THD

*Instructions: The information contained in this document is **COMPANY CONFIDENTIAL** and may not be disclosed to others without prior authorization. Submit this disclosure to the HP Legal Department as soon as possible. No patent protection is possible until a patent application is authorized, prepared, and submitted to the Government. See http://legal.hp.com/formtool/forms/idf/ for more instructions on filling out this form.*

Descriptive Title of Invention: Structure and Method for Roll-to-Roll Patterning and Aligning Multiple Layers

Name of Project: PIRM

Product Name or Number:

Was a description of the invention published, or are you planning to publish? If so, the date(s) and publications(s):
no

Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, the date(s) and location(s):
no

Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, the date(s) and name(s):
no

If any of the above situations will occur within 3 months, call your IP attorney or the Legal Department now at 1-888-4919 or 970-898-4919

Was the invention described in a lab book or other record? If so, please identify (lab book #, etc.):
no

Was the invention built or tested? If so, the date:
no

Was this invention made under a government contract? If so, the agency and contract number:
no

Description of Invention: *Please preserve all records of the invention and attach additional pages for the following. Each additional page should be signed and dated by the inventor(s) and witness(es).*

A. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.).
B. Advantages of the invention over what has been done before.
C. Problems solved by the invention.
D. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).

Signature of Inventor(s): Pursuant to my (our) employment agreement, I (we) submit this disclosure on this date: October 14, 2002

Employee No.	Name	Signature	Telnet	Mailstop	Entity & Lab Name
583139	Ping Mei	Ping Mei	857-5137	1198	HPL/IAL/STD

(If more than four inventors, include additional information on another copy of this form and attach to this document)

1

Exhibit A

HPL INVENTION DISCLOSURE

Signature of Witness(es): *(Please try to obtain the signature of the person(s) to whom invention was first disclosed.)*

The invention was first explained to, and understood by, me (us) on this date:

Full Name	Signature	Date of Signature
CARL P. TAUSSIG	Carl Taussig	10/15/02
Full Name	Signature	Date of Signature

Inventor & Home Address Information: *(If more than four inventors, include addl. information on a copy of this form & attach to this document)*

Inventor's Full Name

Street

City Zip

Do you have a Residential P.O. Address? P.O. Box City State Zip

Greeted as *(nickname, middle name, etc.)* Citizenship US

Inventor's Full Name

Street

City State Zip

Do you have a Residential P.O. Address? P.O. Box City State Zip

Greeted as *(nickname, middle name, etc.)* Citizenship

Inventor's Full Name

Street

Name of Project: PIRM

City Zip

Do you have a Residential P.O. Address? P.O. Box City State Zip

City Zip

Description of Invention: *Please preserve all records of the invention and attach additional pages for the following. Each additional page should be signed and dated by the inventor(s) and witness(es).*

A. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).

Roll-to-roll patterning is one of the key technologies to enable low cost fabrication of electronic devices on plastic substrates. One method employed in the roll-to-roll patterning process is imprint lithography. Imprint lithography is typically utilized to pattern thin films on a substrate material with high resolution. The thin films patterned can be dielectrics, semiconductors, metals or organics and can be patterned as thin films or individual layers. Imprint lithography is particularly useful for patterning devices in a roll-to roll environment since imprint lithography is not as sensitive to planarity as conventional photolithography. Additionally, imprint lithography has a higher throughput and can handle wider substrates.

Typically, the fabrication of an electronic device will require several patterning steps that often must be aligned with each other with a degree of accuracy approaching or even exceeding the minimum feature size. In conventional photolithography, optical alignment marks are used to guarantee alignment between successive patterning steps. Although, it is possible to use optical alignments in a roll-to-roll process it is not practical for several reasons. First, the lack of planarity of the substrate in a roll-to-roll environment causes difficulties in the accuracy with which optical alignments can be made due to depth of field restrictions and other optical aberrations. Next, the flexible substrates used in roll-to-roll processing may experience dimensional changes due to variations in temperature, humidity, or mechanical stress. These contractions or dilations of one patterned layer with respect to the next may make alignments of a large area impossible.

In our recent patent application (DD Number: 100203146), a method and system to solve the above problems are described. The invention involves the utilization of a stamping tool to generate three-dimensional resist structures whereby thin film patterning steps can be transferred to the resist in a single molding step and subsequently revealed in later processing steps. Accordingly, the alignments between successive patterning steps can be determined by the accuracy with which the stamping tool has been fabricated, regardless of the dilations or contractions that can take place during the fabrication process.

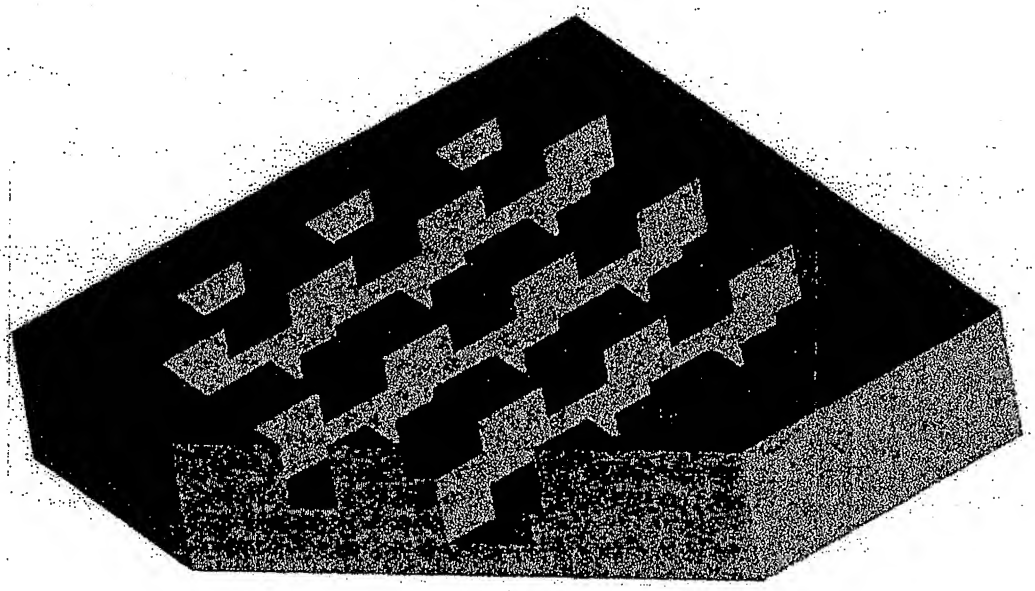
The present invention discloses alternative methods and structures to align patterns of multiple levels in roll-to-roll patterning processes. The key concept is that 2-dimensional alignment features can be created in 3-dimensional structures on a device substrate prior to any processing steps. Subsequent processing steps, including material deposition, planarization, and anisotropic etching, will construct a multi-level aligned pattern.

The proposed method has the following features:

1) It allows for a high temperature process between the first patterned material and the second patterned material, since the proposed method does not rely on an imprint polymer structure.
2) The proposed 3-dimensional structure on a substrate relaxes the constraint on the aspect ratio of the 3-dimensional features. Whereas in a direct imprinting process, the aspect ratio of the features is limited by the material properties of the stamp.
3) The proposed 3-dimensional structures on a substrate can be made either by an imprinting process with a 3-dimensional stamp or by any non-imprinting processes. Therefore, its use has broad applications.

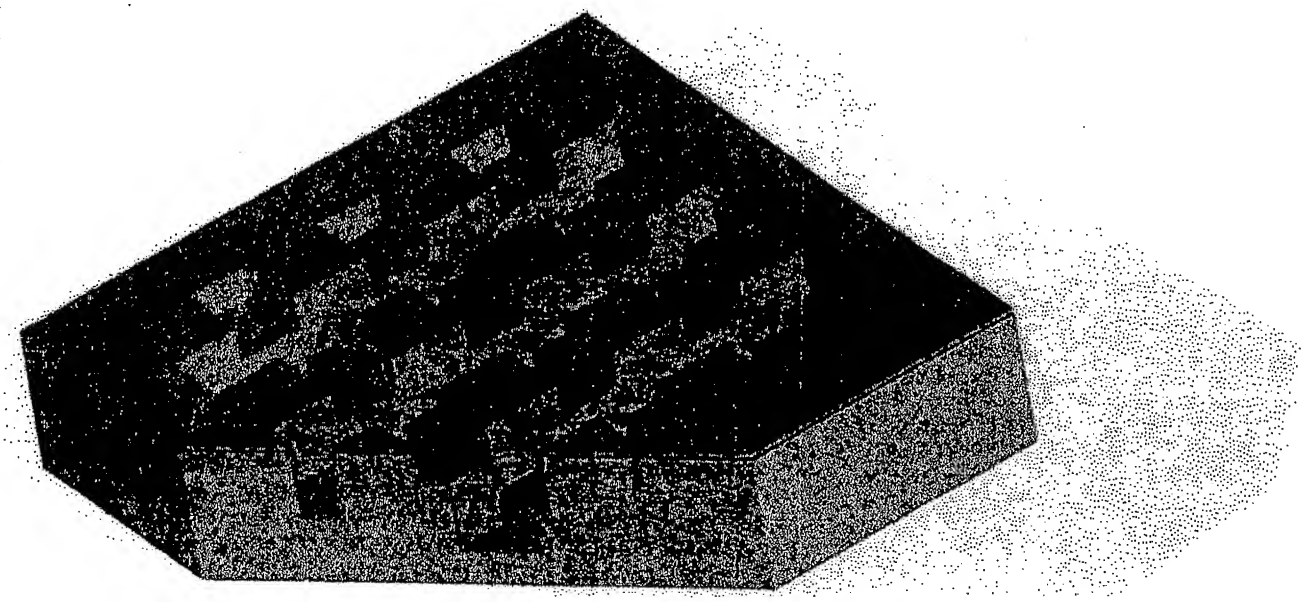
A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).

Method for Making Cross-Point Memory Array



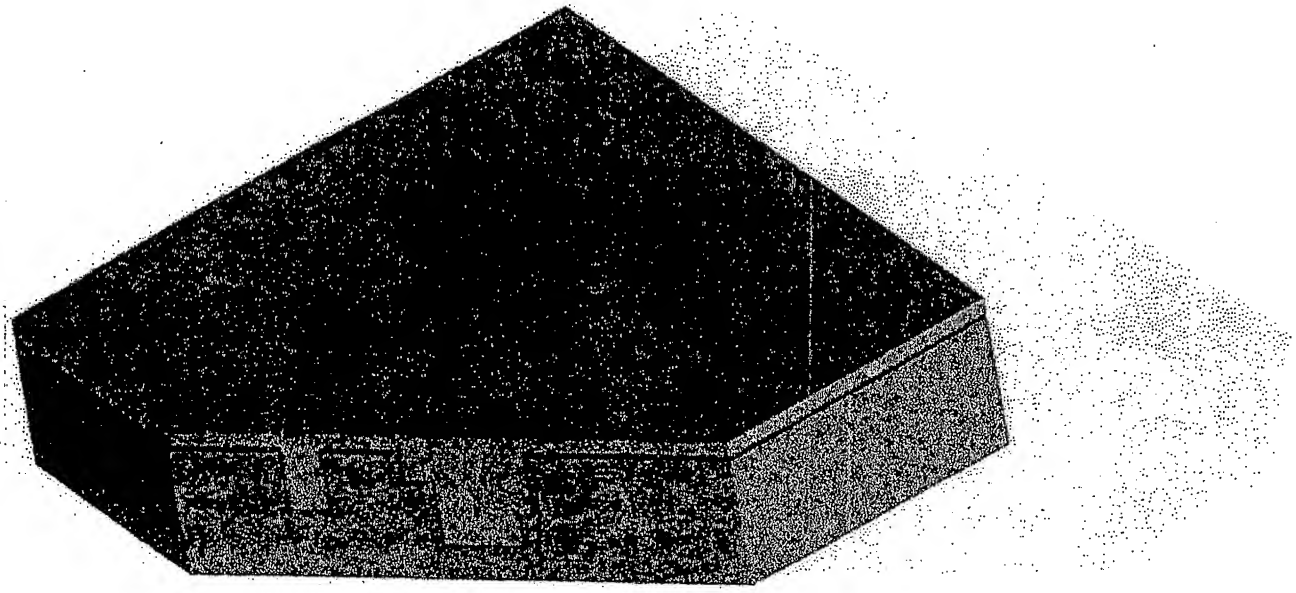
In the first step, 3-dimensional structures are formed on a substrate. The details of forming a 3-dimensional structure are described in the next section. The substrate can be polyimide plastic sheet with or without inorganic coating on a plastic substrate. The structure showing above should be able to sustain temperate of least 250 C.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



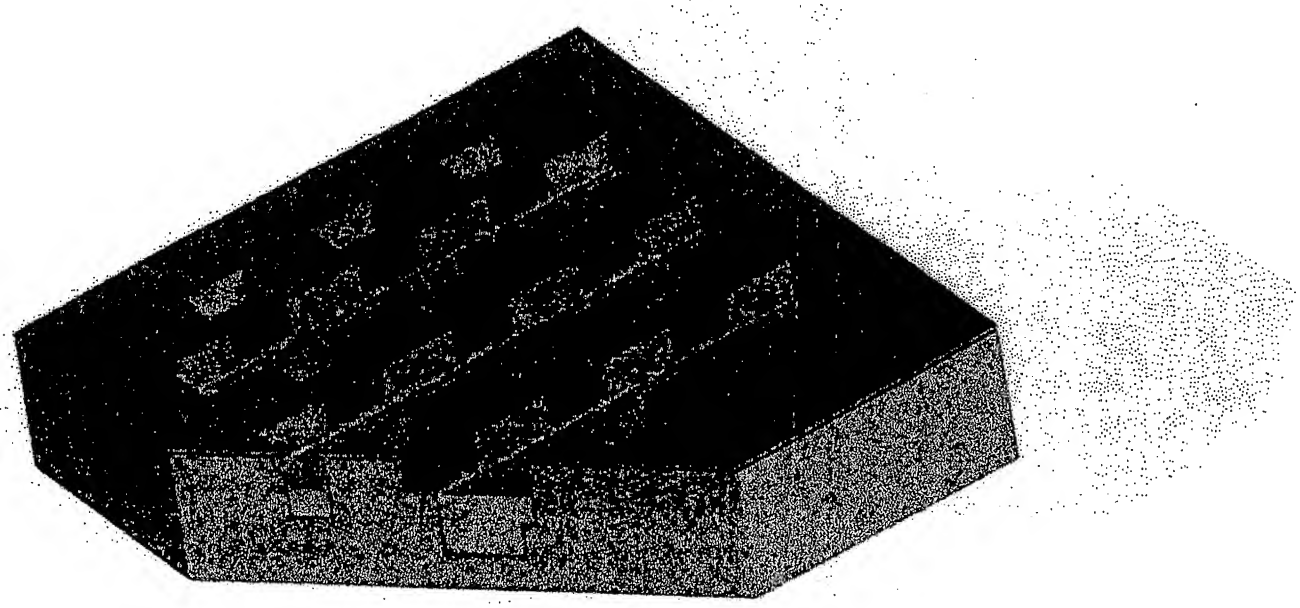
In the next step, a stack of a metal film and organic or inorganic materials are deposited on the substrate. If the deposition is highly directional, a tapered sidewall profile is required for the 3-dimensional structured substrate, in order to have good step coverage for the stack.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



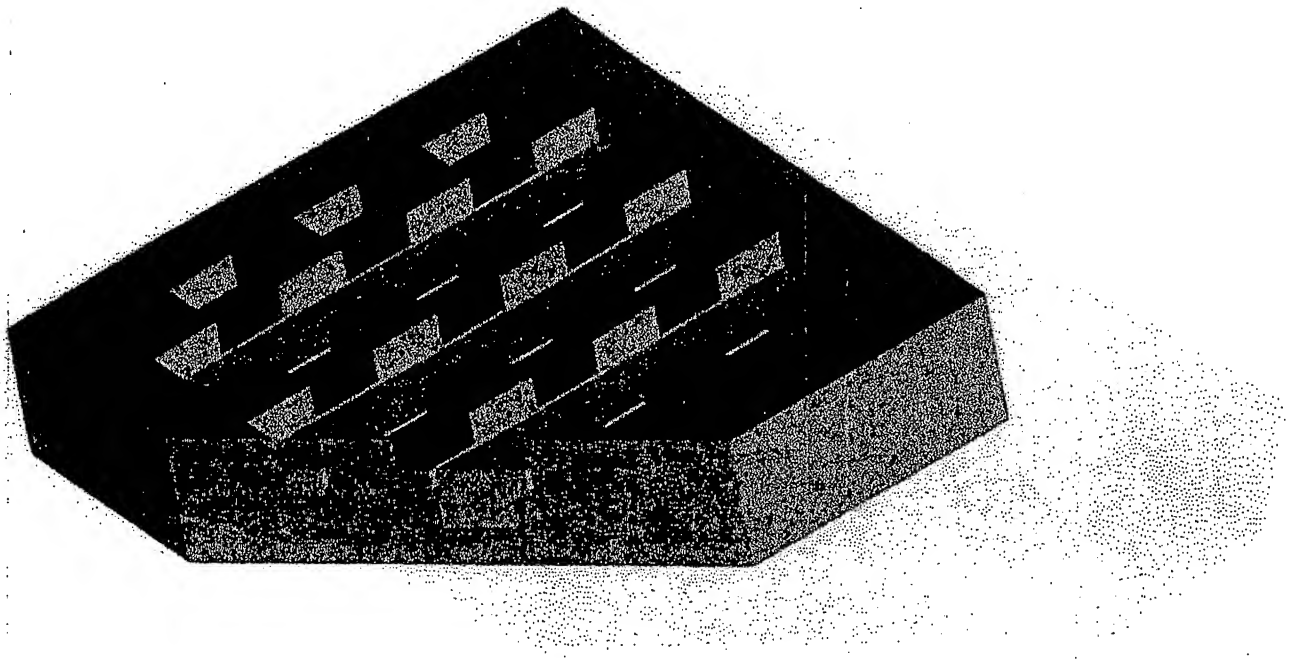
In this step, a planarization polymer is applied to the structure. Examples of the planarization polymers are photo resist, uv-curable polymers, and spin-on-glass.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



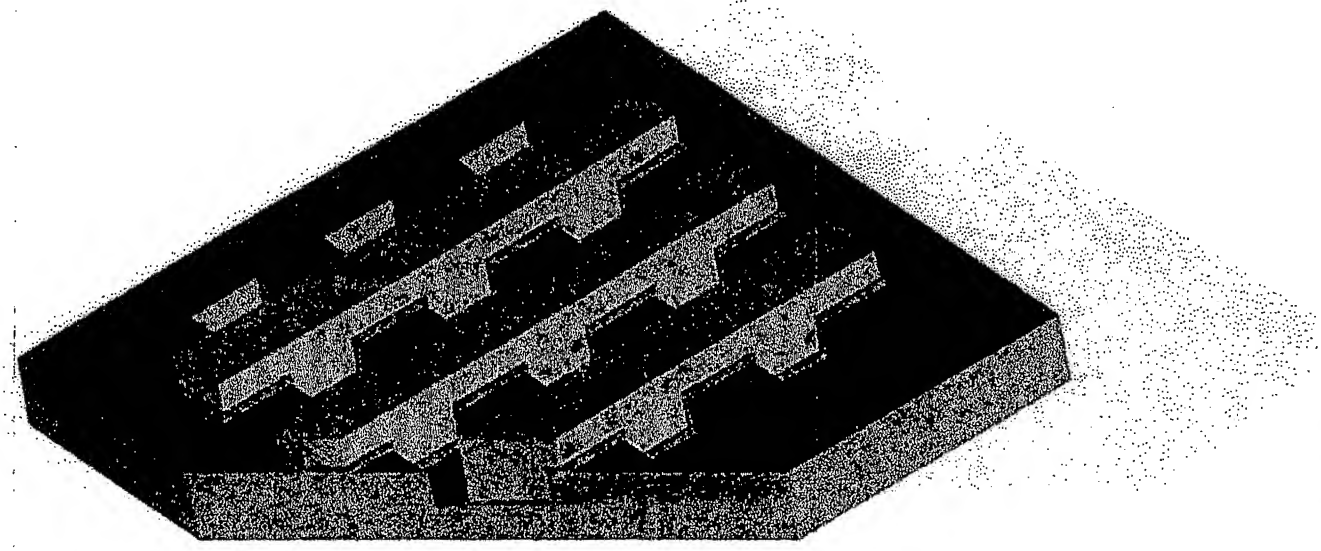
In this step, the planarization polymer is thinned down by a reactive ion etch process. The etching can be either isotropic or anisotropic. The etching is selectivity with respect to the thin film stack.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



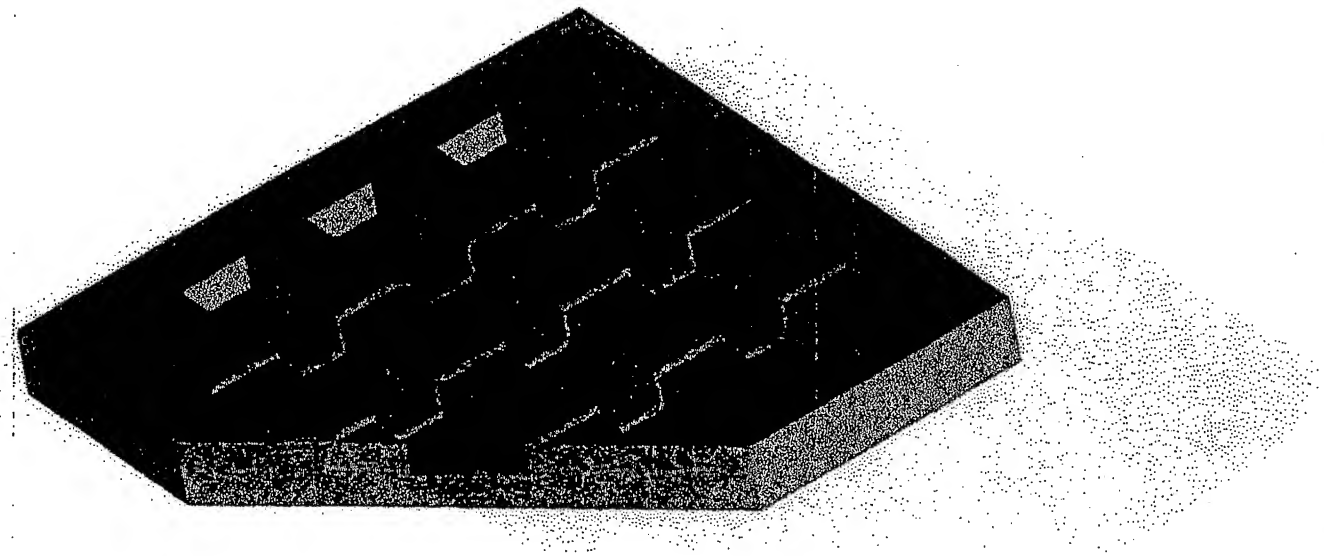
In this step, the first said stack is etched with the planarization polymer as the etch mask. The etch has a selectivity to remove the thin film stack but not the planarization polymer or the substrate.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



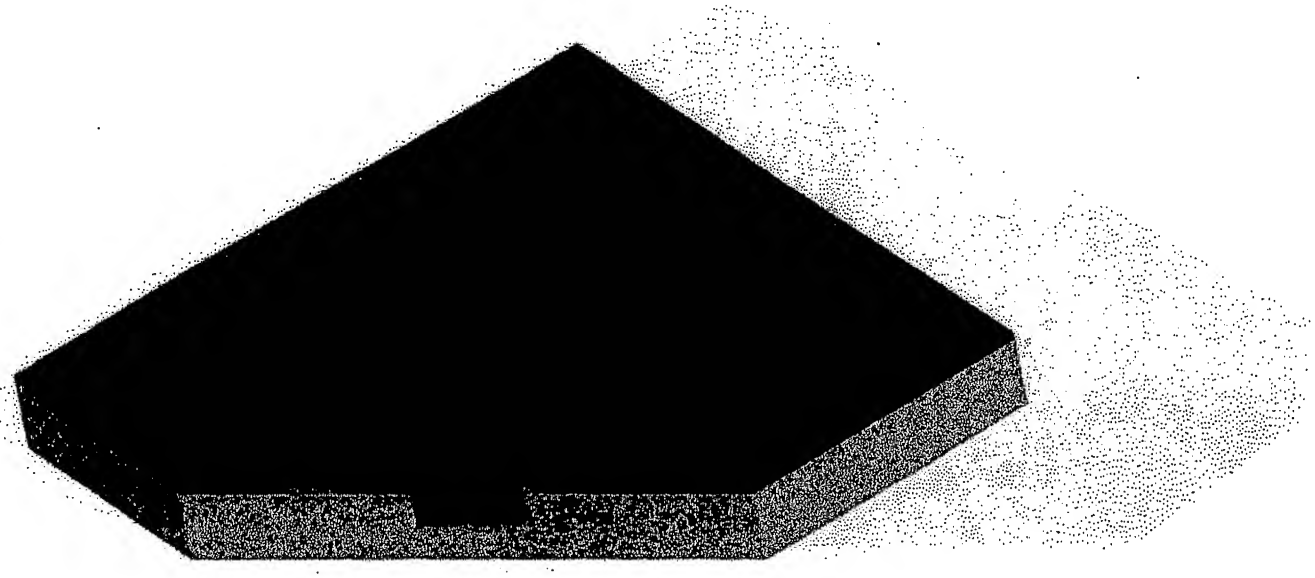
In this step, the substrate is thinned down by an anisotropic reactive ion etching. Since this etching step utilizes the planarization polymer as the mask, a selectivity between the planarization polymer and the substrate is required.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



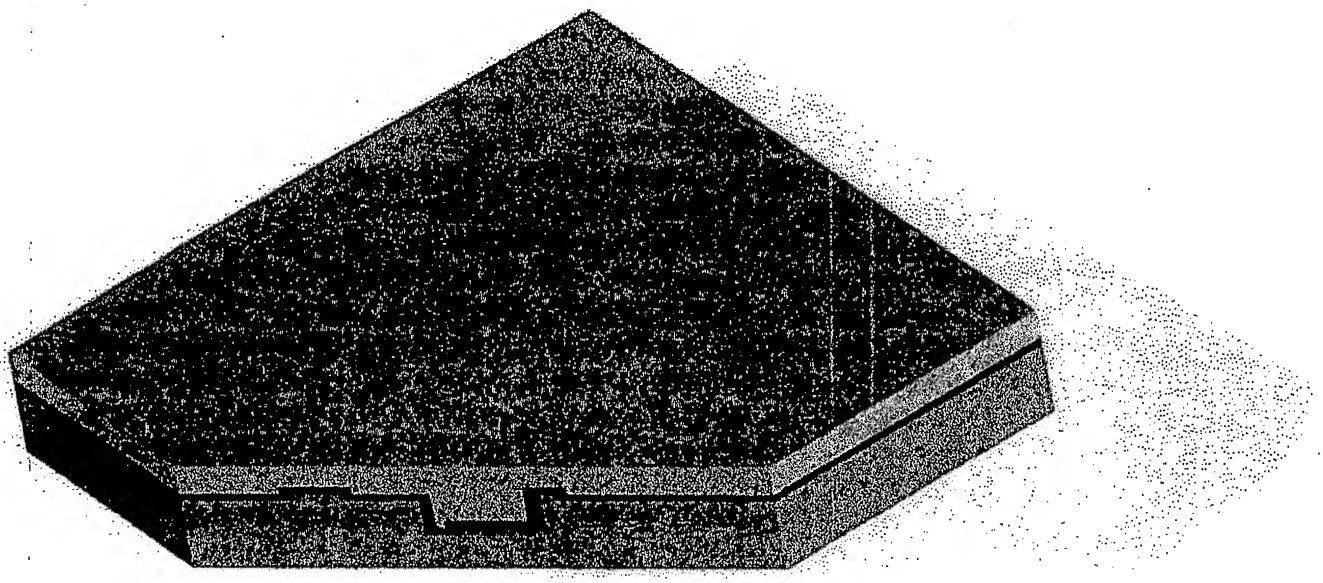
In this step, the planarization polymer is removed. This step constructs patterns for parallel bottom electrodes covered with an anti-fuse material (such as a-Si) and doped a-Si.
The subsequent processing steps complete the cross-point memory array comprises two layers of orthogonal sets of spaced parallel conductors arranged with a semiconductor layer therebetween. The two sets of conductors form row and column electrodes overlaid in such a manner that each of the row electrodes intersects each of the column electrodes at exactly one place.

A. (Cont'd) Description of the construction and operation of the Invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



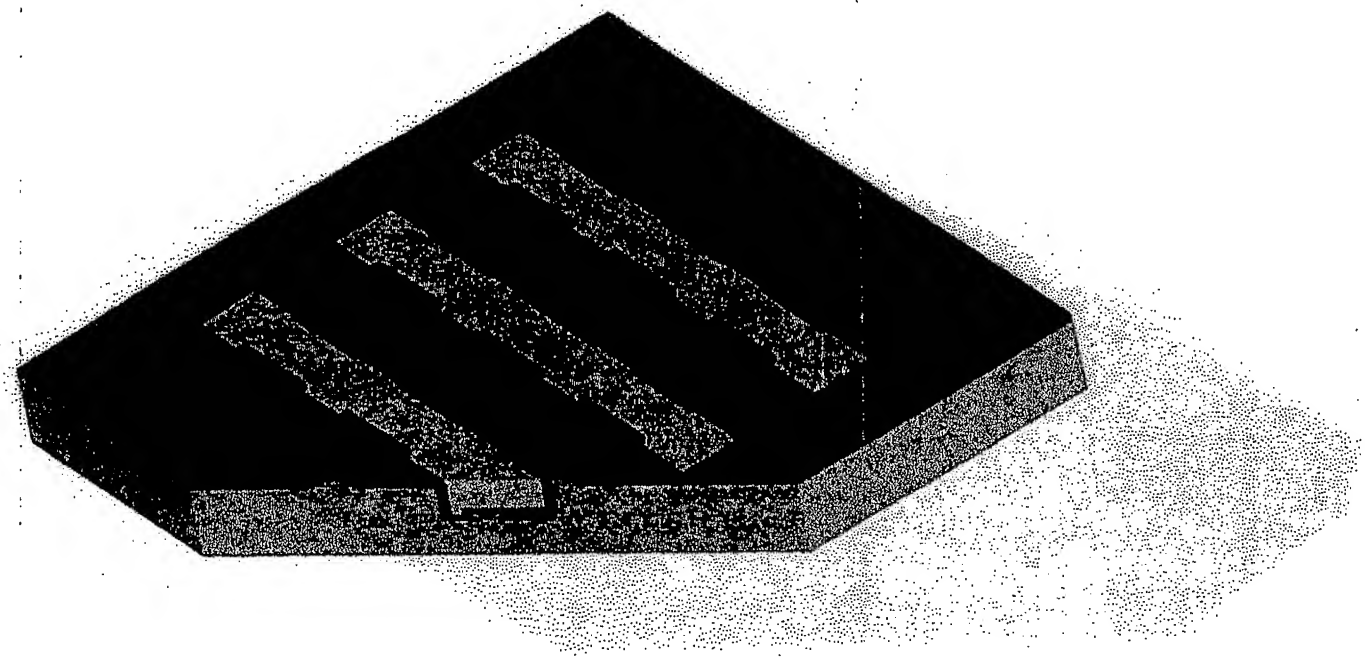
In this step, a second stack of organic or inorganic materials and a metal film are deposited.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



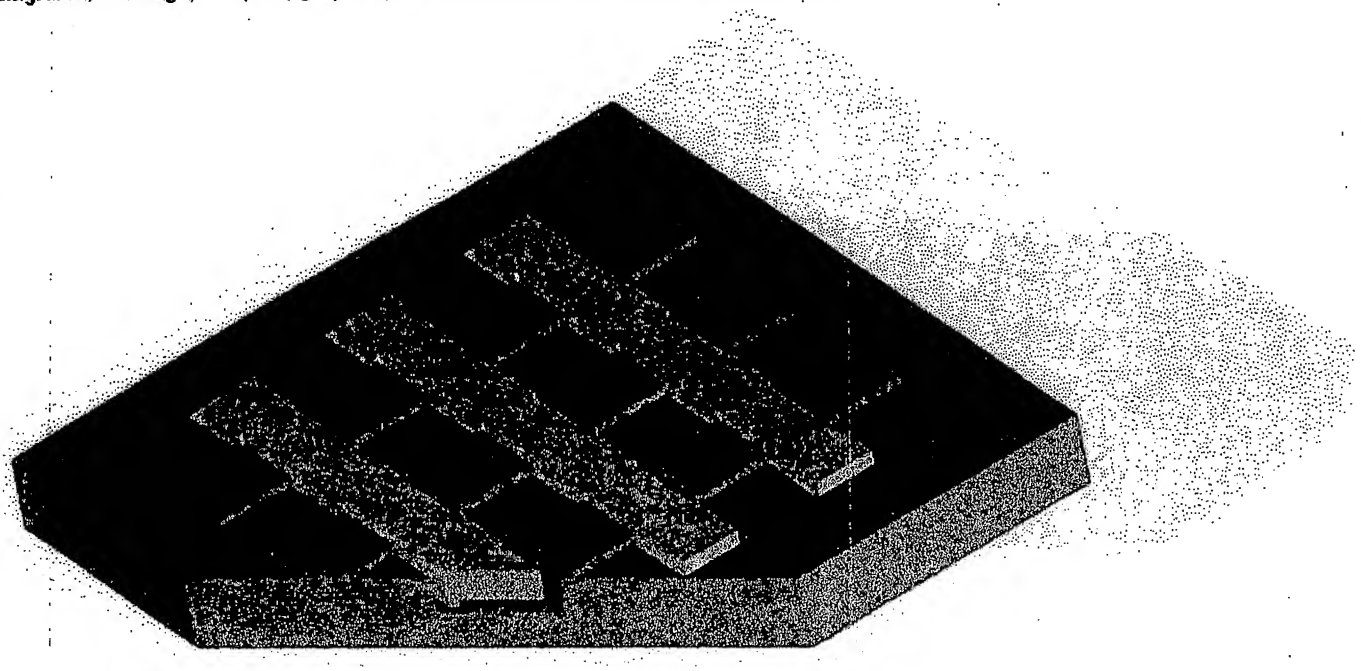
In this step, the same or different planarization polymer is applied to the processing surface.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



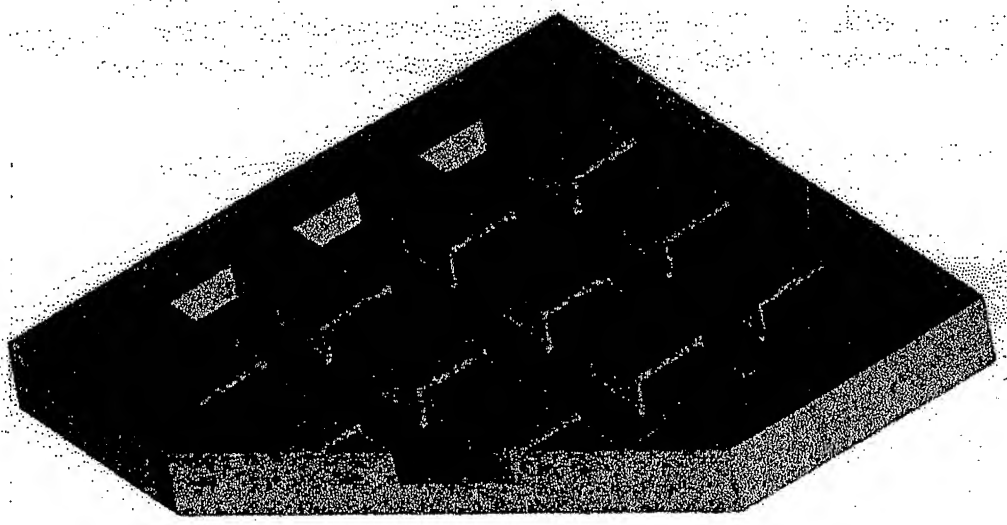
In this step, the planarization polymer is thinned down by a reactive ion etching process. This etching process can be isotropic or anisotropic.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



In this step, the said second stack is etched by an anisotropic reactive ion etching, with the planarization polymer as the etch mask.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).



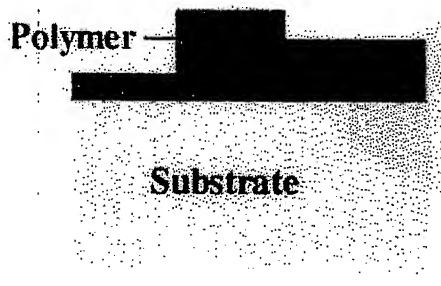
Finally, the planarization polymer is removed. The said first stack may contain a metal film, a layer of intrinsic Si, and a doped Si. The second stack may contain a layer of intrinsic a-Si, a doped Si, and a metal film. Therefore, each cross over point is an anti-fuse memory switch in connection with an a-Si diode.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).

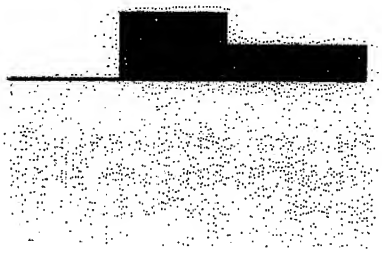
Method for Making 3-Dimensional Structure on a Substrate

There are several ways to make 3-dimensional structures on a substrate in a roll-to-roll fabricate environment. For example, one may use the 3-D imprinting stamp, as disclosed in DD#100203146 to form 3-D polymer structures on the substrate by a roll-to-roll imprinting process. The shape of the 3-D polymer structure can be then transferred to the substrate by a sequence of polymer thinning and substrate etching processes. The figures shown below (cross-section view) describes a detailed example of shape transfer from the polymer to the substrate.

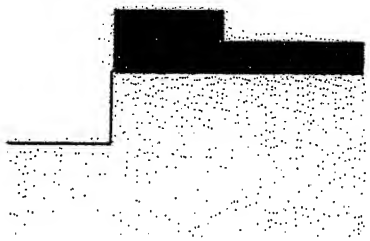
(1) Imprinting polymer on the substrate



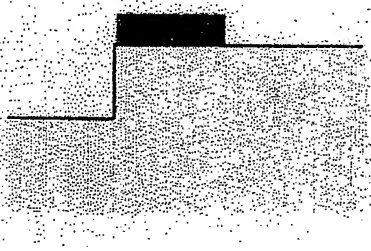
(2) Thinning down the polymer



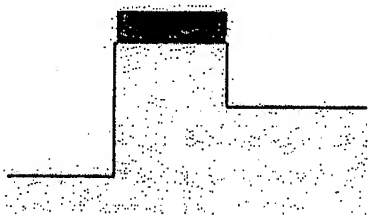
(3) Etching the substrate



(4) Thinning down the polymer again



(5) Etching the substrate again



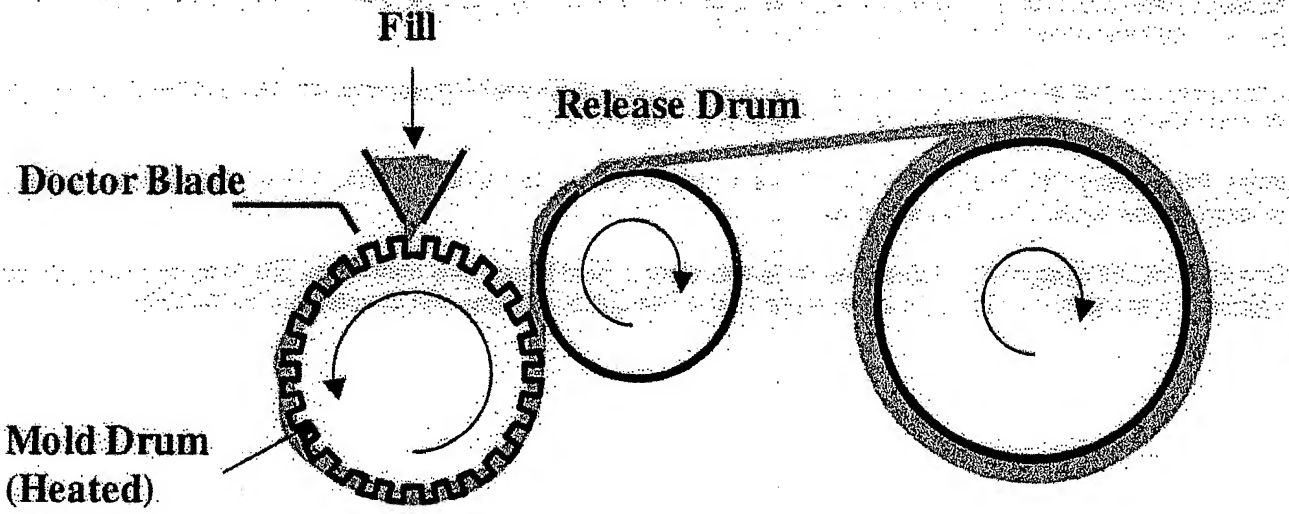
(6) Polymer shape is transferred to the substrate.

A. (Cont'd) Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc).

Since in the above process the depth of the profile in the substrate is determined by the RIE etching process for the substrate, the profile made in the substrate can be much deeper compared to the 3-dimensional polymer mask. In another word, the shape of the polymer structure can be amplified in the substrate. This feature allows for a wider process window for making the imprinting stamp with a small aspect ratio.

Alternatively, the 3-dimensional structure on a substrate may be formed by a molding process. For example, the 3-dimensional profile can be made on a metal or ceramic piece. A liquid compound of polyimide precursor will be filled into the mold, thermally cured, and released from the mold. The figure showing below illustrates this process.

Other methods to make 3-dimensional structure on a substrate in a roll-to-roll fabrication environment may include laser ablation process and focused ion-etching process.



B. Advantages of the invention over what has been done before (specifics as to why this approach is better than previous solutions).

1)It allows for a high temperature process between the first patterned material and the second patterned material, since the proposed method does not rely on an imprint polymer structure.

2)The proposed 3-dimensional structure on a substrate relaxes the constrain on the aspect ratio of the 3-dimensional features. Whereas in a direct imprinting process, the aspect ratio of the features is limited by the material properties of the stamp.

3)The proposed 3-dimensional structures on a substrate can be made by either imprinting process with a 3-dimensional stamp or any non-imprinting processes. Therefore, there are less restrictions on its applications.

C. Problems solved by the invention (description of the existing problems that this invention addresses).

Aligning multiple patterning steps with sub-micron resolution in a roll-to-roll environment

D. Prior solutions and their disadvantages (describe what others have done and the shortcomings of these solutions; if available, attach copies of product literature, technical articles, patents, etc.).

Photolithography: alignments are performed optically this cannot accommodate dilations or contractions of the web between subsequent patterning steps. Also the accuracy of optical alignments and of the resolution of features produced by photolithography are limited by the flatness of the web.

Laser ablation: this technique suffers from the same drawbacks as photolithography with the additional concern that the thermal effects caused by ablation may damage the patterned films

Inkjet: the largest problem with inkjet is that the minimum feature size is not consistent with micron-scale devices. Also the process is slow since it must be scanned.

One level imprint lithography: It improves the single layer imprint lithography method by providing an extremely accurate alignment method for multiple patterning steps that is immune to dilations and contractions of the web

Request for Quote and Engagement Letter Agreement

RE: Hewlett-Packard (HP) Docket No.: 200209576-1
Date: April 9, 2003

X This is a request for a quote for the following services:

____ This is a confirmation of your quote for the following services:

PREPARE

X Application — X File with USPTO

____ Response — ____ Return to HP for filing

X Other: YOUR FINISHED PRODUCT TO HP SHOULD INCLUDE ALL ITEMS ON THE ENCLOSED CHECKLIST

HP REQUIRED DATES: September 26, 2003 Date for Receipt by HP

September 26, 2003 Date to be Filed in PTO

HP Attorneys of Record: (to be included on the Declaration)
Customer Number 022879

HP Primary Technical Contact: ALL INVENTORS SEE DISCLOSURE FOR DETAILS
Telephone:
HP Entity:
Address:

ADDITIONAL TERMS OR INSTRUCTIONS:

TOTAL PRICE: $ 8700 **(Including Formal Drawings)**
Total Price to include up to a 2 hr. preliminary patentability search unless otherwise instructed by HP Attorney

I agree to the terms of this Agreement including the additional terms above, pursuant to the HP Procedures for Outside Counsel revised **November 2001**, which I have received and reviewed. This Agreement will not be binding on either party until signed by an authorized representative of HP.

Attorney at your firm handling this matter: Wendell J. Jones

Law Office of Wendell J. Jones
By: Wendell J. Jones
Wendell J. Jones
Dated: 4/9/03

HEWLETT-PACKARD COMPANY
By: Brian R. Short
Brian R. Short
Dated: 4/10/03

Exhibit B

Wendell J. Jones

From: Wendell J. Jones [wjjones@hightechlawyer.net]
Sent: Wednesday, November 05, 2003 10:32 PM
To: Mei, Ping
Subject: 200209576-1 First Draft of Claims

Hi Ping,

Here is my first crack at the claims for the above-referenced HP disclosure related to roll-to-roll processing and aligning multiple layers. Please let me know what you think.

Wendell

Exhibit C

Wendell J. Jones

From: Wendell J. Jones [wjjones@hightechlawyer.net]
Sent: Friday, December 19, 2003 11:17 AM
To: ping_mei@hp.com
Subject: First Draft of 200209576-1 patent applicatioin

Hi Ping,

Here is a first draft of the above referenced patent application. Please review and provide me with comments as soon as you can. You can make changes to the soft copy and email them to me if you would like. Thank you.

Wendell

Exhibit D